Public Health England

Protecting and improving the nation's health

Formic Acid

Incident Management

Key Points

Fire

- flammable when exposed to heat or flame
- reacts with alkalis and oxidising materials such as peroxides, nitric acid and chromic acid
- emits toxic fumes of carbon monoxide when heated to decomposition or on contact with strong acids
- in the event of a fire involving formic acid use alcohol-resistant foam or fine water spray and liquid-tight chemical protective kit with breathing apparatus

Health

- inhalation causes irritation of the eyes and nose with sore throat, cough, chest tightness, headache, tachycardia and confusion
- ingestion causes immediate burning of the mouth and throat, drooling, difficulty swallowing, abdominal pain, vomiting and haematemesis
- haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases
- dermal exposure causes pain, blistering, ulceration, necrosis and coagulation burns
- ocular exposure causes pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia

Environment

- avoid release to the environment; inform the Environment Agency of substantial incidents

PHE publications gateway number: 2014790
Published: October 2015

Hazard Identification

Standard (UK) dangerous goods emergency action codes

Formic acid, with more than 85% acid by mass

UN		1779	Formic acid, with more than 85% acid by mass	
EAC		•2W	Use alcohol-resistant foam but, if not available, fine water spray can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off should be prevented from entering drains and watercourses.	
APP		A (fl)	Gas-tight chemical protective suit with breathing apparatus† Flammable liquid	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	3	Flammable liquids	
HIN		83	Corrosive or slightly corrosive substance, flammable (flash point between 23°C and 60°C inclusive)	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

† Normal fire kit in combination with gas-tight chemical protective clothing conforming to BS EN 943 part 2, thermal-resistant gloves should be worn such as those conforming to BS EN 511:2006 or BS EN 407:2004

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015.

Formic acid, with not less than 10% but not more than 85% acid by mass

UN		3412	Formic acid, with not less than 10% but not more than 85% acid by mass	
EAC		•2X	Use alcohol-resistant foam but, if not available, fine water spray can be used. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses	
APP		–	–	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive substance	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015.

Formic acid, with not less than 5% but not more than 10% acid by mass

UN		3412	Formic acid, with not less than 5% but not more than 10% acid by mass	
EAC		2X	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses	
APP		–	–	
Hazards	**Class**	8	Corrosive substances	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive substance	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* Chemical protective clothing with liquid-tight connections for whole body (type 3) conforming to the relevant standards such as BS 8428 or EN 14605, in combination with breathing apparatus BS EN 137

Reference

Dangerous Goods Emergency Action Code List, National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA, The Stationery Office, 2015.

Classification, labelling and packaging (CLP)*

Hazard class and category	Skin Corr. 1A	Skin corrosion, category 1A	
Hazard statement	H314	Causes severe skin burns and eye damage	
Signal words	DANGER		

Specific concentration limits

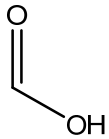
Concentration	Hazard class and category	Hazard statement	
C ≥ 90%	Skin Corr. 1A	H314	Causes severe skin burns and eye damage
10% ≤ C < 90%	Skin Corr. 1B	H314	Causes severe skin burns and eye damage
2% ≤ C < 10%	Skin Irrit. 2	H315	Causes skin irritation
2% ≤ C < 10%	Eye Irrit. 2	H319	Causes serious eye irritation

* Implemented in the EU on 20 January 2009

Reference

European Commission. Harmonised classification – Annexe VI to Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 05/2015).

Physicochemical Properties

CAS number	64-18-6
Molecular weight	46.03
Formula	CH_2O_2
Common synonyms	Hydrogen carboxylic acid, formylic acid, aminic acid, methanoic acid
State at room temperature	Colourless fuming liquid
Volatility	Vapour pressure = 33.55 mmHg at 20°C, slightly volatile
Specific gravity	1.2 (water = 1)
Flammability	Flammable when exposed to heat or flame
Lower explosive limit	18%
Upper explosive limit	51%
Water solubility	Miscible with water
Reactivity	May react with alkalis and oxidising materials such as peroxides, nitric acid and chromic acid. Aluminium reduces formic acid with incandescence. Incompatible with sulphuric acid. Forms explosive reaction with furfuryl alcohol, hydrogen peroxide and organic matter, nitromethane
Reaction or degradation products	Decomposes on heating and on contact with strong acids to liberate carbon monoxide
Odour	Pungent, penetrating odour
Structure	

References

The Merck Index (14th Edition). Entry 4241: Formic Acid, 2006.

Formic acid (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US (electronic version). RightAnswer.com, Inc, Midland MI, US. http://www.rightanswerknowledge.com (assessed 05/2015).

International Programme for Chemical Safety (IPCS). International Chemical Safety Card (ICSC) entry for Formic acid. ISCS 0485, 1997. World Health Organization: Geneva.

Reported Effect Levels from Authoritative Sources

Exposure skin contact

%	Signs and symptoms	Reference
>10	Strongly corrosive	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values.

Reference

a EFSA FEEDAP Panel, 2014. Scientific opinion on the safety and efficacy of formic acid when used as a technological additive for all animal species. EFSA Journal 2014; 12(10): 3827, 16 pp.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (ppm)	Calculated value (mg m^{-3})
ERPG-1*	3(1)	5.76
ERPG-2†	25	48
ERPG-3‡	250	480

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour

† Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

‡ Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

(1) Odour threshold should be detectable near ERPG-1

Reference

American Industrial Hygiene Association (AIHA). 2014 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2014%20ERPG%20Values.pdf (accessed 06/2015).

Acute exposure guideline levels (AEGLs)

	ppm				
	10 min	30 min	60 min	4 hours	8 hours
AEGL-1*	Data not available				
AEGL-2†					
AEGL-3‡					

* Level of the chemical in air at or above which the general population could experience notable discomfort

† Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape

‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death

Exposure Standards, Guidelines or Regulations

Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	5	9.6	No guideline value specified	

WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

Reference
EH40/2005 Workplace Exposure Limits (second edition, published 2011).

Public health guidelines

Drinking water standard	No guideline value specified
Air quality guideline	No guideline value specified
Soil guideline values and health criteria values	No guideline value specified

Health Effects

Major route of exposure

- inhalation, ingestion, dermal and eye contact

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Ingestion	Immediate pain with burning in the mouth, throat and stomach, which may be followed by abdominal pain, vomiting, haematemesis and dyspnoea. Pain and oedema may make swallowing difficult, causing drooling. Acids can damage the stomach causing ulceration, gangrene, haemorrhage and perforation. In severe cases extensive areas of the gastrointestinal tract may be involved Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases Stridor and respiratory complications (including pneumonitis, pulmonary oedema, ARDS and pulmonary necrosis) can develop following aspiration of corrosive materials **Systemic effects** include circulatory collapse, metabolic acidosis, hypoxia, respiratory failure, acute renal failure, haemolysis and disseminated intravascular coagulation (DIC)
Inhalation	Irritation of eyes and nose with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion. Chemical pneumonitis, tachypnoea, dyspnoea and stridor due to laryngeal oedema may follow Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36 hours to develop Optic neuropathy has been reported following both acute and chronic inhalation Severe inhalation injuries may result in persistent hoarseness, pulmonary fibrosis and chronic obstructive airway disease Prolonged exposure may cause systemic effects
Dermal	Acids (including gaseous and fumes) may cause pain, blistering, ulceration and penetrating necrosis Coagulation burns may develop, which can be self-limiting and superficial with the destruction of the surface epithelium and sub-mucosa forming a leathery crust which limits the spread of the product. Systemic toxicity has been reported following skin burns
Ocular	Eye contact may cause pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia may occur. Acidic solutions may cause corneal burns

References

TOXBASE. Formic acid, 04/2015. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Corrosives – ingestion, 06/2016. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Chemicals splashed or sprayed into the eyes, 02/2014. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Skin decontamination – corrosives, 06/2010. http://www.toxbase.org (accessed 11/2016).

TOXBASE. Corrosives – inhalation, 02/2012. http://www.toxbase.org (accessed 11/2016).

Decontamination at the Scene

Summary

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

Formic acid is a corrosive substance. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

People who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination.

Emergency services and public health professionals can obtain further advice from Public Health England (Centre for Radiation, Chemical and Environmental Hazards) using the 24-hour chemical hotline number: 0344 892 0555.

Disrobe

The disrobe process is highly effective at reducing exposure to HAZMAT/CBRN material when performed within 15 minutes of exposure.

Therefore, disrobe must be considered the primary action following evacuation from a contaminated area.

Where possible, disrobe at the scene should be conducted by the casualty themselves and should be systematic to avoid transferring any contamination from clothing to the skin. Consideration should be given to ensuring the welfare and dignity of casualties as far as possible.

Improvised decontamination

Improvised decontamination is an immediate method of decontamination prior to the use of specialised resources. This should be performed on all contaminated casualties, unless medical advice is received to the contrary. Improvised dry decontamination should be considered for an incident involving chemicals **unless the agent appears to be corrosive or caustic**.

Improvised dry decontamination

- any available dry absorbent material can be used such as kitchen towel, paper tissues (eg blue roll) and clean cloth
- exposed skin surfaces should be blotted and rubbed, starting with the face, head and neck and moving down and away from the body

- rubbing and blotting should not be too aggressive, or it could drive contamination further into the skin
- all waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage

Improvised wet decontamination

- water should only be used for decontamination where casualty signs and symptoms are consistent with exposure to caustic or corrosive substances such as acids or alkalis
- wet decontamination may be performed using any available source of water such as taps, showers, fixed installation hose-reels and sprinklers
- when using water, it is important to try and limit the duration of decontamination to between 45 and 90 seconds and, ideally, to use a washing aid such as cloth or sponge
- improvised decontamination should not involve overly aggressive methods to remove contamination as this could drive the contamination further into the skin
- where appropriate, seek professional advice on how to dispose of contaminated water and prevent run-off going into the water system

Additional notes

- following improvised decontamination, remain cautious and observe for signs and symptoms in the decontaminated person and in unprotected staff
- if water is used to decontaminate casualties this may be contaminated, and therefore hazardous, and a potential source of further contamination spread
- all materials (paper tissues etc) used in this process may also be contaminated and, where possible, should not be used on new casualties
- the risk from hypothermia should be considered when disrobe and any form of wet decontamination is carried out
- people who are contaminated should not eat, drink or smoke before or during the decontamination process and should avoid touching their face
- consideration should be given to ensuring the welfare and dignity of casualties as far as possible. Immediately after decontamination the opportunity should be provided to dry and dress in clean robes/clothes
- people who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination

Interim wet decontamination

Interim decontamination is the use of standard fire and rescue service (FRS) equipment to provide a planned and structured decontamination process prior to the availability of purpose-designed decontamination equipment.

Decontamination at the scene references

National Ambulance Resilience Unit. Joint Emergency Services Interoperability Programme (JESIP). Initial operational response to a CBRN incident. Version 1.0, September 2013.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Chemical incidents: planning for the management of self-presenting patients in healthcare settings. April 2015.

Clinical Decontamination and First Aid

Clinical decontamination is the process where trained healthcare professionals using purpose-designed decontamination equipment treat contaminated people individually.

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important note

- if the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves. The area should be well ventilated
- carry out decontamination after resuscitation; resuscitate the patient according to standard guidelines

Clinical decontamination following surface contamination

- carry out decontamination after resuscitation
- this should be performed in a well-ventilated area, preferably with its own ventilation system
- do **not** apply neutralising chemicals as heat produced during neutralisation reactions may cause thermal burns, and increase injury
- contaminated clothing should be removed, double-bagged, sealed and stored safely
- decontaminate open wounds first and avoid contamination of unexposed skin
- any particulate matter adherent to skin should be removed and the patient washed with copious amounts of water under low pressure for at least 10–15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5–6, although it may be closer to 7 in children, or after irrigation). **The earlier irrigation begins, the greater the benefit**
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- decontaminate (as above) the patient following surface contamination
- following decontamination recheck the pH of affected areas after a period of 15–20 minutes and repeat irrigation if abnormal; burns with strong solutions may require irrigation for several hours or more
- once the pH is normal and stabilised, treat as for a thermal injury
- burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns
- moderate/severe chemical burns should be reviewed by a burns specialist

- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- remove contact lenses if present
- anaesthetise the eye with a topical local anaesthetic (eg oxybuprocaine, amethocaine or similar); **however, do not delay irrigation if local anaesthetic is not immediately available**
- immediately irrigate the affected eye thoroughly with 1,000 mL 0.9% saline (eg by an infusion bag with a giving set). A Morgan Lens may be used if anaesthetic has been given. Irrigate for 10–15 minutes irrespective of initial conjunctival pH. Aim for a final conjunctival pH of 7.5–8.0. The conjunctivae may be tested with indicator paper. Retest 20 minutes after irrigation and use further irrigation if necessary
- repeated instillation of local anaesthetics may reduce discomfort and help more thorough decontamination; however, prolonged use of concentrated local anaesthetics is damaging to the cornea
- patients with corneal damage, those who have been exposed to strong acids or alkalis and those whose symptoms do not resolve rapidly should be referred **urgently** to an ophthalmologist
- other supportive measures as indicated by the patient's clinical condition

Inhalation

- maintain a clear airway and ensure adequate ventilation
- give oxygen if required
- perform a 12 lead ECG
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- **maintain airway and establish haemodynamic stability**
- in severely affected patients critical care input is essential. Urgent assessment of the airway is required. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction
- do **not** attempt gastric lavage
- do **not** give neutralising chemicals as heat produced during neutralisation reactions may increase injury
- the use of water or milk (maximum initial volume = 100 - 200 mL in an adult; 2 mL/kg in a child) as diluents in the management of corrosive ingestion may be of some symptomatic benefit (but caution is necessary following large ingestions where mucosal damage / perforation may have already developed). There is experimental evidence to suggest that

early dilution therapy with water or milk reduces acute alkali injury of the oesophagus but administration of large volumes of fluid should be avoided as they may induce vomiting and increase the risk of oedema

- monitor blood pressure, pulse and oxygen saturation
- perform a 12 lead ECG in all patients who require assessment
- other supportive measures as indicated by the patient's condition

Clinical decontamination and first aid references

TOXBASE: http://www.toxbase.org (accessed 11/2016)

TOXBASE: Formic acid, 04/2015

TOXBASE: Corrosives – ingestion, 06/2016

TOXBASE: Chemicals splashed or sprayed into the eyes, 02/2014

TOXBASE: Skin decontamination – corrosives, 06/ 2010

TOXBASE: Corrosives – inhalation, 02/2012

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

For queries relating to this document, please contact: generaltox@phe.gov.uk

First published: October 2015

Update: November 2016 Health Effects, Decontamination at the Scene & Clinical Decontamination and First Aid